MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1 2022/2023 (TERM ID 2210 & TERM ID 2215)

ECT2036 – CIRCUITS AND SIGNALS

(TE, RE)

17 FEBRUARY 2023

9:00 am – 11:00 am
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This Question paper consists of 6 pages including cover page with 4 Questions only.

2. Attempt **ALL** the questions. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please write all your answers in the Answer Booklet provided.

4. Appendix is provided after the question pages.

Question 1

Given the network in Figure Q1(a) and the graph in Figure Q1(b),

i. List down all fundamental loops.

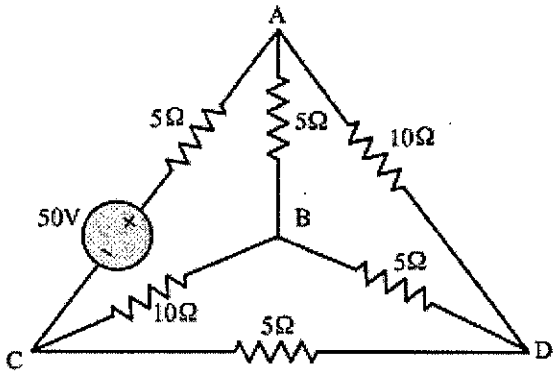
[3 marks]

ii. Write down the fundamental loop matrix, D.

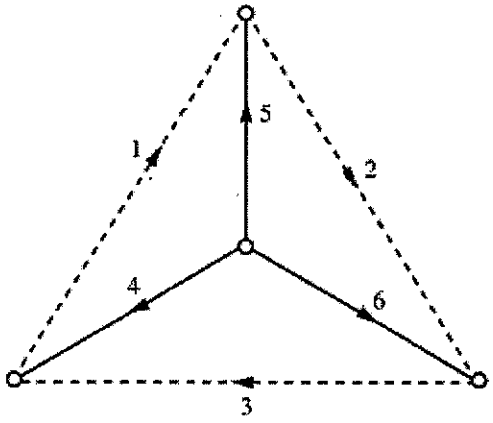
[6 marks]

iii. Using fundamental loop analysis, find all the branch voltages, e and branch currents, i. Given $i_1 = 4.1666$ A, $i_2 = 1.6666$ A and $i_3 = 2.5$ A

[16 marks]



(a)



(b)

Figure Q1

Continued...

Question 2

(a) Sketch the x(t) given below and determine whether the signal is a power signal or energy signal or neither.

$$x(t) = \begin{cases} 2 & \text{for } -1 \le t \le 0 \\ 2e^{-t/2} & \text{for } t > 0 \end{cases}$$

[8 Marks]

(b) Plot the even and odd parts of the signal $x(t)$ as shown in Figure Q2.1.

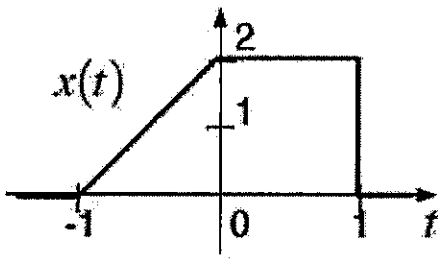


Figure Q2.1

[8 Marks]

(c) Given two signals x(t) and h(t) as shown in Figure Q2.2, find and plot y(t) = x(t)*h(t)

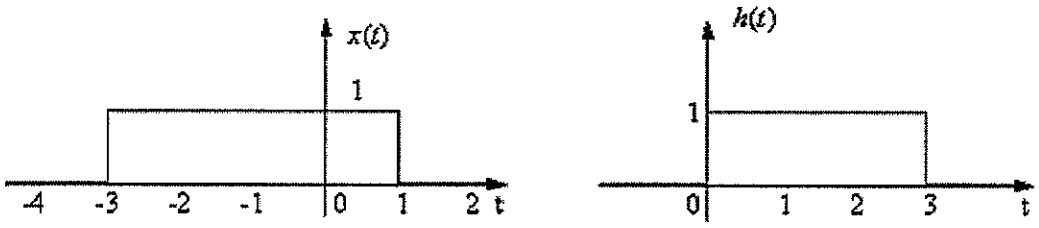


Figure Q2.2

[9 Marks]

Continued...

Question 3

(a) List five properties of the Hurwitz Polynomial.

[5 marks]

(b) Given the Z(s) of the RC networks as below, find Foster first form.

$$Z(s) = \frac{(s+1)(s+3)}{s(s+2)}$$

[10 marks]

(c) Given the Z(s) of the RC networks as below, find Cauer first form.

$$Z(s) = \frac{(s+2)}{(s+1)(s+3)}$$

[10 marks]

Question 4

Given the following specifications for a low pass filter,

Passband to stopband frequency ratio = 0.125
Maximum passband attenuation, A_P = 4dB
Minimum stopband attenuation, A_S = 60dB
Cutoff frequency,

i) Find the order of the filter by using Butterworth and Chebyshev approximations

[12 marks]

ii) Synthesize the Butterworth filter with a cut-off frequency equals to 0.5×10^6 rad/s and a load impedance of 1Ω.

[13 marks]

Continued...

APPENDIXES

Chapter 1:

Nodal Analysis	**Mesh Analysis**
1. $Y_N = AYA^T$	1. $Z_M = BZB^T$
2. $e_{\text{Node}} = -Y_N{}^{-1}A(I+YE)$	2. $i_{\text{Mesh}} = Z_M{}^{-1}B(E+ZI)$
3. $e = A^T e_{\text{Node}}$	3. $i = B^T i_{\text{Mesh}}$
4. $i = Ye + (I+YE)$	4. $e = Zi - (E+ZI)$
Fundamental Cutset Analysis	**Fundamental Loop Analysis**
1. $Y_C = CYC^T$	1. $Z_L = DZD^T$
2. $e_{\text{Twig}} = -Y_C{}^{-1}C(I+YE)$	2. $i_{\text{Link}} = Z_L{}^{-1}D(E+ZI)$
3. $e = C^T e_{\text{Twig}}$	3. $i = D^T i_{\text{Link}}$
4. $i = Ye + (I+YE)$	4. $e = Zi - (E+ZI)$

Chapter 2:

Even signal: $f(t) = f(-t)$ or $f[n] = f[-n]$

Odd signal: $f(t) = -f(-t)$ or $f[n] = -f[-n]$

Energy content: $E = \lim_{T\to\infty} \int_{-T}^{T} f^2(t)dt$ or $E = \lim_{N\to\infty} \sum_{n=-N}^{N-1} f^2[n]$

Power content: $P = \lim_{T\to\infty} \frac{1}{2T} \int_{-T}^{T} f^2(t)dt$ or $P = \lim_{N\to\infty} \frac{1}{2N} \sum_{n=-N}^{N-1} f^2[n]$

Chapter 7:

Transformation from normalised LPF to other denormalised filters

Normalised LPF	C_N	L_N	R_N=1Ω
Denormalised LPF ω_C	$C = \frac{C_N}{\omega_C R_L}$	$L = \frac{L_N R_L}{\omega_C}$	R_L
Denormalised HPF ω_C	$L = \frac{R_L}{\omega_C C_N}$	$C = \frac{1}{\omega_C R_L L_N}$	R_L
Denormalised BPF $BW = \omega_{C2} - \omega_{C1}$ $\omega_O = \sqrt{\omega_{C1}\omega_{C2}}$	$L_P = \frac{BWR_L}{\omega_O^2 C_N}$ $C_P = \frac{C_N}{BWR_L}$	$L_S = \frac{L_N R_L}{BW}$ $C_S = \frac{BW}{\omega_O^2 L_N R_L}$	R_L
Denormalised BSF $BW = \omega_{C2} - \omega_{C1}$ $\omega_O = \sqrt{\omega_{C1}\omega_{C2}}$	$L_S = \frac{R_L}{BWC_N}$ $C_S = \frac{BWC_N}{\omega_O^2 R_L}$	$L_P = \frac{BWL_N R_L}{\omega_O^2}$ $C_P = \frac{1}{BWR_L L_N}$	R_L

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Lowpass Filter Design – Butterworth

Selectivity parameter: $k = \frac{\omega_S}{\omega_P}$

Discrimination parameter: $k_1 = \sqrt{\frac{10^{0.1A_S} - 1}{10^{0.1A_P} - 1}}$

Order of filter: $n = \frac{\log k_1}{\log k}$ (n is round up as $\lceil n \rceil$)

Lowpass Filter Design – Chebyshev

Selectivity parameter: $k = \frac{\omega_S}{\omega_P}$

Discrimination parameter: $k_1 = \sqrt{\frac{10^{0.1A_S} - 1}{10^{0.1A_P} - 1}}$

Order of filter: $n = \frac{\cosh^{-1} k_1}{\cosh^{-1} k}$ (n is round up as $\lceil n \rceil$)

Butterworth Filter Synthesize

Order n	C_{1N} (F)	L_{1N} (H)	C_{2N} (F)	L_{2N} (H)	C_{3N} (F)
1	2	-	-	-	
2	1.4142	1.4142	-	-	-
3	1	2	1	-	-
4	0.7654	1.8478	1.8478	0.7654	-
5	0.6180	1.6180	2	1.6180	0.6180

$C_{\frac{k+1}{2}N} = 2\sin\frac{(2k-1)\pi}{2n}, k = 1,3,5,...$

$L_{\frac{k}{2}N} = 2\sin\frac{(2k-1)\pi}{2n}, k = 2,4,6,...$

End of paper.